Childhood Brain Cancer and Potential Residential Exposure to Toxics Release Inventory Chemicals during Pregnancy

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INTRODUCTION

While the susceptibility of the developing fetus to various chemical exposures is well documented, the role of environmental chemicals in childhood brain cancer etiology is not well understood.

One source of information on environmental contaminants is the Toxics Release Inventory (TRI) published by the United States Environmental Protection Agency (EPA). TRI is an annual report of chemical releases to the environment and transfers of chemicals to off-site locations. The TRI database has been used in several studies and has afforded a link to slight increases in risk for certain birth defects associated with toxic releases. However, no previous published studies have examined the relationship between childhood brain cancers and environmental chemicals released from TRI facilities.

The primary objective of this analysis was to determine if mothers of childhood brain cancer cases had greater potential residential exposure to TRI chemicals than control mothers during pregnancy. Potential exposure was defined as residing near any TRI facility or TRI facility emitting carcinogens of varying toxicity and quantity levels during pregnancy.

METHODS

Eligible cases:

- All incident cases of first primary childhood brain cancer, excluding lymphomas, diagnosed at <10 years of age during 1993-1997, and identified from the statewide cancer registries of Florida, New Jersey, New York (excluding New York City), and Pennsylvania.
- Born in the United States after 1987; biological mother available for an interview by telephone.

One to one matched controls:

- Children without cancer selected by random digit dialing.
- Matched on race, birth year, and state of residence at the time of case's diagnosis.

Data Collection:

- Biological mothers of 382 cases and 382 controls were interviewed in English using a computer assisted telephone interview system.
- Addresses of mothers during pregnancy were geocoded and used with the geographic coordinates of the TRI facilities to measure exact distance to all TRI facilities within two miles of each residence.

Exposure Assessment:

- First, we investigated the distance to the nearest TRI facility at any point in pregnancy and categorized the exposure levels as residing ≤ 1 mile vs. > 1 mile and ≤ 2 miles vs. > 2 miles of any facility.
- Second, the release of any carcinogen to the air from facilities ≤ 1 mile vs. > 1 mile and ≤ 2 miles vs. > 2 miles of pregnancy residence was investigated.
- Lastly, an exposure index was created by adapting the chronic index (CI) developed by EPA Region III *(Neumann CM, Forman DL, Rothlein JE. 1998. Hazard screening of chemical releases and environmental equity analysis of populations proximate to Toxic Release Inventory facilities in Oregon. Environ Health Perspect 106:217-26).*
  - CI uses toxicity factors and total mass of emissions during a calendar year to estimate the relative hazards of TRI chemical releases.
  - To calculate the exposure index, we incorporated the duration of potential exposure and residential distance to the facilities into the CI. Only known and possible carcinogens (as defined by the EPA) released ≤ 1 and ≤ 2 miles of pregnancy residence and having the appropriate carcinogenic information available were included. An individual exposure index was calculated for each carcinogen meeting the above criteria by:
    $CI \times (\text{duration in months}/12) \times (1/\text{distance}^2)$
  - The final exposure index was calculated by summing up the individual exposure indices.

Data Analysis:

- Odds ratios (OR) and 95 percent confidence intervals (95% CI) for the exposure variables were calculated using conditional logistic regression analysis.

RESULTS

- Mother's education, household income, and age at pregnancy were not significant risk factors for childhood brain cancer.
- Slightly elevated odds ratios were observed for mothers living within 1 mile of a TRI facility and living within 1mile of a facility releasing carcinogens for having children diagnosed with brain cancer (Table 1).
- Significant risk was not observed for the exposure assessment using the exposure index (Table 2).
- Analyses by histological types did not result in significantly elevated risk (Table 3).

DISCUSSION

Strengths:

- This is the first analysis to examine the role of TRI releases and childhood brain cancer.
- This analysis made attempts to improve upon previous methods of exposure assessment using direct distance to TRI facilities, rather than political boundaries (e.g., census track, zip codes), and incorporating the amount as well as the toxicity of chemicals released.
- Residential addresses during pregnancy were obtained from a residential history questionnaire rather than from birth certificate information, and included multiple addresses when applicable.

Limitations:

- TRI data cannot determine actual exposure to the public; they are estimated reports of releases.
- Chronic Index calculations were limited to those chemicals with toxicity information available.
- TRI is just one source of information on environmental releases.
- Further studies may be conducted to determine if potential exposure during early childhood might increase risk of childhood brain cancer.

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Table 1. Odds ratios for residential proximity to any Toxics Release Inventory (TRI) facility and facility releasing carcinogen(s) during pregnancy for childhood brain cancer by reference age.

	All reference ages		Reference age <5 years	
	OR	(95% CI)	OR	(95% CI)
Proximity to any TRI facility				
≤1.0 mile	1.32	(0.96-1.80)	1.66	(1.11- 2.48)
≤2.0 mile	1.15	(0.84-1.56)	1.13	(0.76-1.69)
Proximity to TRI facility releasing carcinogen(s)				
≤1.0 mile	1.48	(1.01-2.17)	1.72	(1.05-2.82)
≤2.0 mile	1.09	(0.80-1.47)	1.02	(0.69-1.51)

* Lived within the set distance of any TRI facility(s) at any point during pregnancy
** Any air releases of known, probable and possible carcinogens as defined by the U.S. Environmental Protection Agency.

Table 2. Odds ratios (OR) for the exposure index categories for childhood brain cancer by reference age.

	All reference ages		Reference age <5 years	
Exposure Index level	OR	(95% CI)	OR	(95% CI)
I	1.00		1.00	
II	1.91	(0.56-1.46)	1.24	(0.67-2.28)
III	1.33	(0.85-2.09)	1.25	(0.67-2.34)
Trend test	p < 0.25		p < 0.38	

* For selected carcinogens released within 2 miles of residence:
(Chronic Index x Duration of residence) x (1 / distance^2).

Level I - Subjects with an exposure index of zero
Level II - Subjects with an exposure index of greater than zero and less than 50% percentile
Level III - Subjects with an exposure index of greater than 50% percentile

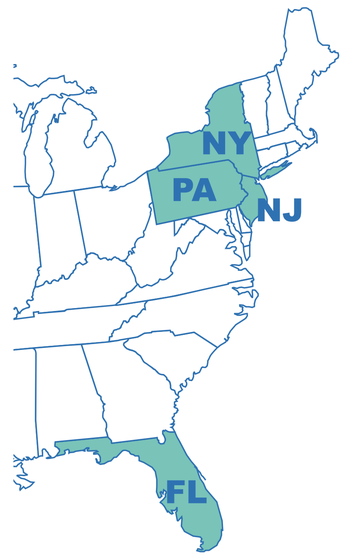

Table 3. Odds ratios for residential proximity to any Toxics Release Inventory (TRI) facility and facility releasing carcinogen(s) during pregnancy for childhood brain cancer by histological types.

	Astrocytoma		Primitive neuroectodermal tumors	
	OR	(95% CI)	OR	(95% CI)
Proximity to any TRI facility				
≤1.0 mile	1.18	(0.77-1.82)	1.39	(0.76-2.55)
≤2.0 mile	1.22	(0.79-1.88)	0.72	(0.41-1.27)
Proximity to TRI facility releasing carcinogen(s)				
≤1.0 mile	1.32	(0.79-2.22)	1.07	(0.52-2.22)
≤2.0 mile	1.03	(0.66-1.59)	0.75	(0.44-1.27)

* Lived within the set distance of any TRI facility(s) at any point during pregnancy
** Any air releases of known, probable and possible carcinogens as defined by the U.S. Environmental Protection Agency

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